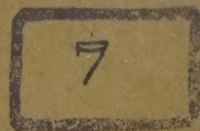


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G62

**Proceedings of a Symposium
on The Use of Non-wheat Flour
in Bread and Baked Goods
Manufacture.**



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This report was produced by the Tropical Products Institute, a British Government organisation which helps developing countries to derive greater benefit from their renewable resources.

It specialises in post-harvest problems and will be pleased to answer requests for information and advice. Reports such as this one are often written as the result of an enquiry.

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Introduction

by Dr E. Asselbergs, F. A. O. Rome (Summarised)

The importance of bread technology can be stated briefly, by reference to the slogan in the F A O symbol: *Fiat Panis*, let there be bread.

F A O became involved in the composite flour programme in about 1964 when they received a letter from New Guinea asking about the use of cassava flour in breadmaking, since to import Australian wheat was difficult and expensive, and the use of a local material would aid development. In the reply it was said that despite the use of cassava during the war, the results had not been of good enough quality to continue, but if there was renewed interest, in the light of present day knowledge, further experiments could be undertaken, but to carry out such research finance would be needed. The enquirer replied that the necessary funds would be made available for such research, and from then work was begun on composite flours.

The use of indigenous raw materials as diluents of wheat is the aim of this project, but the main work so far has been done on cassava starch. Protein supplementation has been mainly soya bean, and to a lesser extent groundnut flour. Although bakery products achieve a fair success, bread still differs widely from the normal standard loaf. To achieve the desirable similarity between the composite flour loaves and conventional bread, a scientific breakthrough was needed and it was felt this should be in a synthetic gluten: and a meeting was held in 1970 in Holland to discuss the possibilities of such a breakthrough. The results of this meeting are briefly: the use of composite flour should not be in competition to that of wheat, thus modifying the original thinking that the composite flour programme should produce a direct substitute for wheat flour. The group felt that bakery products from composite flours should find their way on their own merits. The F A O composite flour programme has been under way for some years in parts of North Africa and Brazil and Peru. The group suggested that additional field programmes should be undertaken; a programme for the promotion of these is now under consideration. The first phase of such a programme is the notification to governments that such a programme exists, and such a document is being produced. Finally the group indicated that biscuits might offer a better use of composite flour than bread: they also indicated that for the moment the production of synthetic gluten was not possible, but further experiments would be made to find other agents.

The beginning of any programme is an idea, such as in F A O, but the principle of profit and commerce must also be accepted in a programme. The problems of hunger throughout the developing world cannot be dealt with by sociologists and economists alone, technologists must be brought in; but despite this there has been a lack of success in the World Food Programme, so that sociologists are now trying to discover what is acceptable to people and why. The situation is a complex one.

The composite flour programme has two major points: one the sponsoring of suitable research programmes, the second the field programmes. Three types of approach have arisen in the research field; they are: 1. TNO work concentrating on bakery products with no wheat flour, using cassava, soya, groundnut, etc.; 2. the TPI composite flours, as used with mechanical dough development etc.; 3. the Kansas State University, USA, where they are experimenting on the use of high protein flours and additives such as soya concentrate in conventional bread. Field programmes must be tried, and the problems raised must be met as they happen. From the trials in hand, types of baked goods are being found suitable for the country where they are to be used. Surveys of the industry and requirements are undertaken with field trials. National government policy also plays an important role in proposed field trials.

It is hoped that this meeting can assist in defining the concept of a composite flour programme; what should it be, what is its position in the context of our own economy, the context of the economic and social development of less fortunate countries and a definition of a strategy: how should it be approached, and what can be done?

Paper 1

WORK OF THE TROPICAL PRODUCTS INSTITUTE ON THE USE OF NON-WHEAT FLOURS IN BREADMAKING by D. A. V. Dendy

A. W. James P. A. Clarke

Over the past decade the introduction of the Chorleywood Bread Process to the British baking industry, was shown to have the advantage that weaker flours could be tolerated in breadmaking. This advance in baking technology reawakened interest in the possible use of blends of wheat with non-wheat materials and this, coupled with the appreciation of the economic advantages to the developing countries which would accompany such a development, initiated a rethinking on wheat flour dilution.

Work at TPI was firstly directed to confirming and extending the scope of previous work, particularly that of Hulse, Pringle and Williams on mechanically developed doughs from composite flours, and to establish and maintain contacts with the countries who show interest. Of all the materials available from the tropics, cassava starch would seem to be the most promising: it is cheap, can be grown with high yields, and it is tasteless. Initial work was, therefore, on the dilution of wheat with cassava starch.

To confirm the value of Mechanical Dough Development (MDD), we took different wheat flours of from 10.5 to 15.5 per cent protein content and diluted each with various proportions of cassava starch. The composite flours thus formed were used to make bread by 3 breadmaking systems; firstly by MDD using 150 ppm ascorbic acid, 0.7 per cent bread fat and 0.4 hp min per lb; secondly by two fermented systems: a straight 3 hour dough, and a 2½ hour sponge with 1 hour dough, in each case using 0.7 per cent bread fat; and thirdly by the Activated Dough Development (ADD) method using 35 ppm L-cysteine, 50 ppm ascorbic acid and 30 ppm potassium bromate, 0.7 per cent bread fat.

From this comparison we have concluded that MDD gives the best bread, not only in Specific Volume but also in crumb texture and softness. This means that MDD enables a significantly higher level of dilution to be made, to arrive at the same quality in bread, typically 10 per cent more of the non-wheat material and the composite than is possible with other breadmaking systems.

Concerning the fermented systems, we have shown that the sponge and dough process gives slightly better bread than a straight dough. There seems to be some advantage in making the addition of non-wheat material at the dough stage, especially with weak wheats. However, the quality improvement is, we feel, outweighed by the disadvantage of not being able to supply a complete composite flour mixture to the bakers, coupled with the attendant problems to the baker of having to weigh out and add the non-wheat material separately.

Our experience with ADD indicates that this process gives similar specific volumes to MDD, in that it better tolerates non-wheat material than do fermented systems, using strong wheat flours. It has been our experience, however, that crumb structure in bread from chemically developed doughs is not quite as fine as that from mechanically developed doughs, being similar to that from fermented doughs.

At this stage it is perhaps worthwhile looking at the advantages and disadvantages of the various breadmaking systems in the context of a developing society planning the use of a composite flour.

If a composite flour is to be imposed upon an established industry, then it would be unreasonable to pitch the level of dilution above the limits of toleration of a process which could be incorporated into that industry without involving heavy capital expense. If on the other hand, only certain urban sections of a community are to be considered, which may already be supplied from a central point or where there is no existing bread industry, then new systems, such as MDD, can be considered.

The obvious disadvantage with MDD is that the process is capital intensive; a less obvious but more serious drawback is that the process demands large increases in yeast level, and in most developing countries yeast is imported at quite high cost. This, together with the cost of treatment by ascorbic acid, could amount to 40 per cent of the saving in foreign exchange gained by the change-over to MDD. For this reason we have given thought to the broth systems. A reduction of 40 per cent in the initial yeast usage has been achieved by "yeast growth" in a 10 per cent sucrose solution with small amounts of soya flour added as yeast nutrient. This broth was allowed to ferment for one hour before its addition to the dough. It was found helpful to use a yeast stimulant and, in this work, we found 300 ppm of ammonium chloride satisfactory.

You will notice that we specify 0.7 per cent bread fat in this recipe, which is the normal MDD requirement; we would mention that it is possible to replace this with glyceryl mono-stearate (GMS). but to combat the more rapid staling that occurs with breads from composite flours, it is necessary to use higher than normal levels. We have found that although 0.2 per cent GMS to flour weight is sufficient to give optimum volume, this level does not retard staling rate to the same extent as 0.7 per cent bread fat. To effect the same approximate delay to the staling rate, it is necessary to increase the GMS level to 0.5 per cent.

We have tried a variety of emulsifiers with anti-staling properties and have found that sucrose monopalmitate, at 0.5 per cent, gave best volume and softness, but texture was more open.

Considering Activated Dough Development:- the obvious advantage is that the process can be accepted by a bakery geared to fermented systems, without involving that bakery in capital expenditure on new equipment. Although from our preliminary work it appears that this process will allow higher dilution levels than normal fermented processes, this advantage must be set against not only the extra cost of yeast, but the cost of the cysteine, bromate and ascorbic acid. Even so, there does still seem to be an economic advantage in the change-over. Possibly the main disadvantage of this process in most small bakeries operating with unskilled labour, is the reduced tolerance to delays in processing.

From these comments, it will be seen how difficult it is to make generalisations with regard to dilution levels.

From the nutritional aspect, a cassava/wheat loaf is not satisfactory as it has a low percentage of poor quality protein; we have therefore studied the making of bread from composite flour enriched with high protein material.

Possibly the most commonly available protein source is soya bean flour, and for this reason we have used soya flour in most of our work. In deciding the protein level to maintain in the composite flours, we have used two methods of approach; firstly, we decided that one criterion could be to maintain the crude protein content at a level similar to a UK Baker's Grade Flour at about 12 per cent. Secondly, we decided to maintain the limiting amino acid lysine at the level of the original flour, which in the case of Canadian Castle flour, which we have used, is about 0.33 per cent of the flour weight. An example of the bread fortified with soya is exhibited. For example, the bread containing 30 per cent total dilution has added to it 3.9 per cent full fat soya, 1 per cent of which is added as enzyme active soya, the rest is heat treated. This fortification gives a total protein in the final loaf of 11.7 per cent and with lysine equivalent to the original wheat flour (i.e. 14.5% protein).

It is perhaps worth mentioning that using MDD and strong flour, we have found that dilutions of up to 10 per cent of full fat heat treated soya can be made without adversely affecting loaf volume.

We have used other high protein materials such as cotton-seed flour prepared by a solvent extraction method (Ward Woodhead) at 3 per cent (based on 100 per cent protein content). This gave a loaf of poor volume, coarse texture, dark colour and strong cotton-seed flavour, though the cotton-seed flour contained no free phenolic materials. Groundnut flour and leaf protein concentrate used at only 1 per cent, each reduced loaf volume, coarsened crumb texture and adversely affected crumb colour and flavour. Fish protein concentrate at 3 per cent gave a grey crumb, poor volume and strong flavour of protein hydrolysate. Eviscerated fish protein can be added to bread at levels of 4 per cent without causing a deterioration in bread quality. A coconut protein concentrate, from a process being developed at TPI, was found eminently suitable as it did not affect the loaf quality, even when 5 per cent was added to the composite.

Correct preparation of the starch and protein materials is very important. For example, if one uses dried, ground and screened cassava tuber as the diluent and compares the loaf produced with that from the blend of cassava starch—that is the washed-out starch—with strong wheat flour, only 20 per cent of the tuber flour can be used compared with 50 per cent for the starch in a simple blend.

Generally speaking, we can say that flours and starches having a high fibre content are not suitable diluents.

In addition to cassava, we have examined certain tropical cereals which were sent to us from developing countries. Invariably MDD was found superior to other methods.

Two varieties of sorghum were studied: not more than 15 per cent of a sorghum flour milled to 80 per cent extraction can be added to the strong wheat flour without depressing the volume of the loaf. The flavour and eating quality of sorghum/wheat bread is excellent, though the crumb is a little grey. Also with MDD, 10 per cent of the sorghum flour could be put into flour from a very weak Sudan grown wheat containing only 9 per cent protein.

A millet flour has been studied and at 20 per cent dilution of the strong Canadian wheat flour, the loaf volume was poor and even at 10 per cent of millet the texture was coarse and the crumb brown. However, the flavour and eating quality were excellent and not unlike a whole-wheat loaf.

Rice flour gave reasonable loaf volume with up to 40 per cent dilution, with excellent crumb softness, good flavour and a fair colour.

In studying blends of maize flour with wheat, we have found that Granulated Maize Meal (GMM) is superior to maize flour in the composite. Using MDD, up to 15 per cent GMM could be included, giving bread of good texture and volume.

Various root crops besides cassava and potato can provide flour for use in breadmaking with composites. A sample of yam flour (spalata) was used in conjunction with a strong wheat flour and it was found that up to 20 per cent of the yam could be used without seriously affecting the volume or crumb of the bread. At the 20 per cent level, the bread was sweeter than ordinary bread, which would be a particularly desirable feature in West Africa and the Caribbean, where bread frequently contains added sugar to cater for local taste.

Having shown in the Test Bakery that it is possible on a small scale to make bread containing only 50 per cent wheat flour by MDD, it was considered desirable to carry out a plant trial in a commercial bakery. (The recipe is shown in Table 1). There were no problems in the dough processing, and the finished bread produced as box and open top loaves, had good texture, though slightly more open than in test baked samples; crumb softness, flavour and staling rates were similar but volume was slightly inferior to bread made to the same recipe in the Test Bakery. It was concluded that only very simple modifications to the settings of the plant bakery would be required.

In conclusion let me say that for developing countries there are obvious benefits from adopting appropriate systems of breadmaking using blends of wheat and non-wheat flours, provided that full consideration is given to the realities of local conditions.

Table 1

Yeast Ferment	Grams
Dried yeast	244
Sucrose	75
Water 38° C	1,500
Dough	
"Castle" wheat flour	9,375
Cassava starch	8,250
Defatted soya flour	1,125
Salt	375
Sucrose	188
Diastatic malt flour	75
Bread fat	131
Ascorbic acid	150 ppm
Water	9,413

Paper 2

BREADMAKING WITH NON-WHEAT FLOURS

by D. de Ruiter, Institute for Cereals, Flour and Bread, TNO, Wageningen, Netherlands

I should like to give you first a brief survey of the work on breadmaking with non-wheat flours that has been done in our Institute, and a summary of its results. Next, a discussion of the essential remaining problems.

Upon request of F A O we started in 1965 a study on the possibility of making bread without wheat flour. In the first instance, a great number of tropical starchy flours were combined with a variety of protein-rich flours and gluten substitutes.

Among the starchy components, products like cassava, yam, maranta, and sago were tried. As protein concentrates soya flour, groundnut flour, cottonseed flour, fish meal and similar products were used. As a substitute for gluten, swelling agents like alginates, vegetable gums and pregelatinised starches were tested, as well as emulsifying agents like lecithin and glyceryl mono-stearate (GMS).

In these experiments best results were obtained with cassava starch combined with soya or groundnut flour, and a GMS-emulsion as an improving agent. Table I shows one of the recipes for cassava/soya bread. These doughs lack the coherence so characteristic in wheat doughs. To enable a non-wheat dough to rise, considerably more water has to be added in doughmaking than is usual in wheat doughs; therefore, the term batters instead of doughs would be more appropriate, and accordingly such batters are prepared with a planetary mixer. The batter can be divided mechanically by a depositor, but it may also be deposited manually.

Cassava/soya and cassava/groundnut compositions lend themselves not only for breadmaking; they may be used also for preparing biscuits, both hard and soft types: biscuit recipes are given in Table II.

Besides this study of the making of baking products without wheat flour, we have in our Institute also tried out to what extent non-wheat flours may be added to wheat flour without too great a change in bread characteristics.

While in England this problem was studied with the use of high-speed mixers, we investigated the effect of improvers in breadmaking according to continental methods with conventional apparatus.

We succeeded in obtaining bread of acceptable quality from wheat flours containing up to 30 per cent of non-wheat flours by adding 0.5 per cent of calcium stearoyl lactylate in the usual Dutch bread-making procedure. The recipe and procedure are given in Table III. The non-wheat component may be made up of cassava or maize flours or starches enriched, if necessary, with soya flour.

How far have we got now with the results? Initially, the investigations were carried out on a laboratory scale; later, commercial scale trials were made on our pilot plant. We hope to start a marketing study in Bogota, Colombia, early in 1971. The test bread will be produced in an experimental bakery with a daily production capacity of 500 kg of bread. Both non-wheat bread and bread from partly substituted wheat flour will be tested.

On the basis of the results of this marketing study the Colombian Government will be advised on a future policy of stimulating cassava (starch) production and manufacturing soya flour.

What are the principal problems ?

(a) in Cassava/Soya bread:

Taste and eating characteristics of the cassava/soya bread are different from those of common wheat bread. This itself is not necessarily an objection; whole wheat bread is also different from white bread, and rye bread has quite different characteristics again. One should, however, be aware of the fact that the cassava/soya bread cannot be offered to the public as a replacement for wheat bread. An extensive consumers' acceptability test and a marketing study should precede the commercial introduction of

this bread type. That is what we actually intend to do in Colombia now.

Another more technical problem is the quality variation limit of raw materials. The raw materials used for the production of this bread are, as a matter of fact, not developed for use as bread flour but for other purposes. The permissible quality variations of these products are therefore at present determined by the other fields of application. On this point further study is needed to establish whether the variation limits for bread making purposes are wider or narrower than they are for the other purposes.

Soya products from one manufacturer and covered by the same specification may at one time meet the requirements well, and at another time less well. New specifications will have to be drawn up. We know already a few factors that play an important part in determining the suitability of a soya flour for breadmaking; among these is the solubility of the protein.

(b) in bread from Composite Flours containing Wheat:

In the substitution of wheat flour by non-wheat flours we have set a limit to the substitution percentage so as to avoid significant deviation of the bread characteristics from those of common wheat bread. It may be assumed, therefore, that few problems will be encountered as to the consumer acceptability. The strongest objections are anticipated from the millers. The opinion of the bakers will also be a point in the acceptance, as the admixture of non-wheat components to wheat flour changes the dough properties and affects its machineability; this may add to the baker's problems.

The tolerable limit of the substitution percentage depends in each actual case on the baking quality of the available wheat. This must be considered both with a view to the machineability of the dough and the bread quality. The higher the protein content of the wheat flour, the more of the non-wheat component can be added.

The dependence on the wheat quality means that in those cases, like Colombia, where wheat is cultivated but the quality is poor, the possibility of mixing with non-wheat flours is restricted to a lower percentage. It may also mean that, if a low quality imported wheat is used a more expensive wheat will have to be imported instead. Also, as bread consumption rises, so wheat imports will increase too.

Table 1: Bread from cassava starch and defatted soya flour

Composition of the batter (in parts by weight)

cassava starch	80	
defatted soya flour (1)	20	
compressed yeast	2	
salt	2	
sugar	4	
GMS as 10% emulsion(2)	10	= glyceryl mono-stearate
CSL	0.2	= calcium stearoyl-2-lactylate
water (3)	70 – 80	

Procedure

mixing	10 minutes
bulk fermentation	40 minutes
remixing	5 – 10 minutes (4)
scaling	
final proof	variable (5)
baking	30 minutes
batter temperature	28° C
oven temperature	230° C

- (1) High cold-water-soluble protein content.
- (2) 1 part of GMS stirred in 9 parts of hot water.
- (3) Exact amount depends on water absorption of the flour.
- (4) Time required depends on mixing intensity.
- (5) Time required depends on the rate of carbon dioxide gas production in the batter.

Table II: Hard and soft biscuits
Composition of the dough (in grams)

Ingredients	Hard biscuits	Soft biscuits
cassava starch	400	400
defatted soya flour	200	200
margarine	140	360
sugar	180	300
invert sugar syrup	6	—
fresh egg	—	60
water	150	130
sodium bicarbonate	5	2.5
ammonium bicarbonate	2.5	—
potassium bitartrate	5	5

Table III: Bread from composite flours containing 70% of wheat flour
Composition of the dough (in parts by weight):

Wheat flour	70
Corn or Cassava starch or flour	25
Soya flour	5
Compressed yeast	2
Salt	2
Sugar	4
Calcium stearyl-2-lactylate	0.5
Water	50–60

Procedure:

Mixing (Artofex mixer)	10 minutes
First fermentation	35 minutes
Knock back	—
Second fermentation	15 minutes
Dividing	—
Intermediate proof	20 minutes
Moulding	
Final proof	about 60 minutes
Dough temperature	28° C
Baking time	30 minutes
Oven temperature	230° C

Paper 3

NUTRITIONAL ASPECTS

By Professor F. Aylward, University of Reading:

It might be useful to spend a few minutes reviewing the general nutritional background to cereals and, what is very much linked to this, the question of food acceptability. There is no need to repeat the truism that no food has any nutritive value unless it is actually eaten.

In looking at nutrition we can say quite simply that the older ideas of nutrition apply both at home and abroad:- we have to deal with calories and energy requirements and also with proteins and other nutrients and protective foods. In discussions on overseas problems, the protein problem has been stressed; this should not obscure the fact that in all the serious literature, and I include here FAO publications, it has been made quite clear that there are really two tasks in low-income countries abroad: firstly to ensure that there are increased supplies of energy foods, and secondly that, in addition, protein and protective food requirements are also increased. The typical farmer in many countries abroad, as indeed at home, often finds it easier to grow food to meet energy requirements than to grow foods rich in proteins; it is only right, therefore, that a great deal of stress should be put on the protein food supplies. We must not, however, forget the importance of calories.

In bread and cereal foods generally, we should recognise that we have major sources of calories and of proteins for populations in many different countries. The varied diets of different parts of the world can be divided into four groups (1) Europe and North America and the Middle East where rye and wheat are imported staples, (2) Central and South America and parts of the U.S. and of Africa where maize (Indian corn) is a major cereal, (3) countries in Asia where rice is extremely important and (4) some parts of Africa where the calories come primarily from root crops. Root crops are low in protein, whereas the cereals such as wheat have a reasonable quantity of protein; rice somewhat less.

Many years ago at a meeting of the British Nutrition Society Dr. Hugh Magee made a very simple statement that deserves repetition at almost any gathering when there is a discussion on food supplies. He pointed out that the actual contribution of any nutrient could be calculated in terms of $A \times B$, where A was the amount of food eaten, and B was the percentage of the nutrient (for example, protein) in that food. The Irish potato, he said was normally considered as a source of calories; it was a much ignored source of protein; although the protein percentage in potato is relatively small it made an important contribution in some countries because of the large quantity of potatoes eaten. In a similar way, most people think of wheat as primarily a source of calories, but wheat protein in this country represents some 25-30 per cent of dietary protein. The same levels are reached in many countries in Europe and in some parts of the developing world.

In considering the importance of bread and other cereal foods we should remember firstly that bread or bread equivalents can be made more important nutritionally by modifying formulations to increase contributions of proteins, vitamins and minerals to the diet, and secondly that bread itself is used as a vehicle for other nutrients in that it is normally eaten with other foods.

In looking at bread formulations, I think it is worth going back to the voluminous literature of the 1940's on work sponsored by the American Dried Milk Institute and other bodies concerned with the production of high protein bread by adding milk solids. Some of the earlier papers are worth reading; the primary objective was to increase the protein content in the typical white loaf and to expand the use of milk, but the investigations showed the technical difficulties and poor results obtained until methods were devised of controlling the quality of the dried milk. Controlled heat treatment was required to secure a satisfactory loaf using milk powder.

This work is relevant to the present symposium because it underlines points already made, namely that the quality of *all* the components in the bread formulation must be considered together. In many countries overseas it is difficult to control quality, first of all because of the absence of control

laboratories, and secondly because of dependence on imported materials. I would emphasise therefore that various cereal formulations can be of great potential use in increasing the protein supply as well as the calorie supply to people in various parts of the world, but that quality control of raw materials is all-important.

Most of the ideas we are discussing today are technically new but the concepts are very old. A few months ago I came across a book on food chemistry written in the 1860's; this contained dictionary-like notes on different foods. The section on buttermilk gave a few lines describing the manufacture and properties and noted that buttermilk was a well-known food in Ireland and was used by the peasantry of Ireland in conjunction with potatoes. The author then went on to say that the buttermilk being high in proteinaceous matter makes up for the deficiencies of the potato. This was written long before we could analyse proteins by chromatography and of course long before vitamins were known. It is part of human experience, that people have learnt to formulate foods in different ways in order to get better nutritional value.

One of the central points of importance in a cereal programme in low income countries arises from the fact that we can think not only of bread as an end in itself but also as a vehicle to encourage the use of other foods, for example, bread and cheese. Such mixtures are of great importance abroad as well as at home. Work has been carried out on the fortification of wheat flour by synthetic amino acids. These trials will yield few results if the local population is maintaining an older habit such as taking a little goat cheese with their bread. This is almost certainly true in parts of Iran where a large sum of money is being spent on trying to see the effects of lysine fortification.

Finally, let me say that I think the programme we are discussing today is extremely important, especially at the present time, when so much human, scientific, technical and financial effort is being put into synthetic proteins. We know that in the U.S.A. a great effort is being made to produce from soya and other protein materials that look like chicken even to the chicken bone and this sort of work is extremely interesting and may be of economic importance in the U.S.A. and in Europe. Much of it, I believe, is irrelevant to the immediate problems of the developing world; what is being discussed here today is relevant.

Paper 4

THE CAMBRIDGE FORMULA LOAF

By A. M. Buchanan, Spillers Ltd.

Prior to the commercial development and introduction to the Cambridge Formula Loaf, no bread or bread-like product existed in palatable form capable of playing a really effective and enjoyable part in serious slimming diets. Fulfilling this need the Cambridge Formula can be described as a low starch, bread-like product offering a startling reduction in carbohydrate content coupled with greatly increased protein and thus the object of development was to meet the needs of slimmers for a palatable product which would not leave the feeling of deprivation of an essentially enjoyable part of the diet. The end result was a loaf satisfying to the appetite enabling the slimmer to comply more comfortably, more easily and more successfully to the constraints of calorie control.

From the medical standpoint the loaf has received professional approval not only in its advantages to slimmers but also in its inclusion in the diets of diabetics. And it has the approval of the British Diabetic Association in this context. The product was the first of its kind and was launched nationally in the UK in 1966, proving to be an immediate success, receiving wide publicity and attention. Now coming on to the question of the development; the philosophy underlying our development of the loaf was based not on the concept that it provided less calories than ordinary bread as it has approximately the same content of ordinary wheat flour bread, but that it would be capable of satisfying the appetite easily by virtue of higher protein and low carbohydrate content, thus simplifying the adherence to a dietary regime. The early work thus involved investigation of experimental mixes based on the supposition that there must be alternatives to the starch ingredients in a dough mixture which would solidify with heat forming a bread like substance and enabling a high protein content to be carried. On this supposition many trials were carried out with a mixture of soya flour and wheat germ, but without acceptable palatability; it was then discovered that within certain blends a synergistic effect occurred, that is a permanent union took place between the mixes with each depending on the other for its full effect. The end product was this slimming loaf, comparable in quality with bread. This process was invented by my colleague Mr C. S. Evans (who is with us this morning) and is protected under British Patent No. 1060071 and also by a patent in many other countries. A typical analysis of the loaf is shown in Table 1. At the 40 per cent moisture basis the protein content is 25.4 per cent compared with around 8 per cent of ordinary bread. And the available carbohydrate (50 per cent) is substantially less than ordinary bread. The dietetic qualities could be listed as very low starch content, good roughage, useful content of unsaturated oils (3.5 per cent polyunsaturates), a good source of vitamin E and nicotinic acid with some iron content. In practical terms the loaf goes far beyond the minimum UK statutory requirements for the descriptions of "high protein", "starch reduced", and "wheat germ". Concerning the raw materials used in its production, these comprise principally wheat protein, processed cooked wheat germ and enzyme inactivated full fat soya flour. All raw materials are derived from natural sources, there are no supplementary enriching and fortifying agents and animal fats are absent. The loaf in practice is produced by a modified form of the high energy, or Chorleywood Bread Process, observing the basic requirements for this method and using compressed bakers yeast as the raising agent, subsequent processing after mixing follows procedures and techniques similar to normal wheat flour bread manufacture.

Reverting to the medical aspects of this product. At the time of development of the early types of this dietary loaf, my Company was collaborating with the Department of Investigative Medicine in the University of Cambridge, in atherosclerosis research, and following on this and also in connection with it, interest grew in the study of obesity. In conjunction with local Cambridge medical practitioners slimming experiments were undertaken. The results were very encouraging and further trials followed. Evidence that the loaf produced better results than ordinary germ bread used as a

control in a calorie controlled diet, was given in a paper read to the Nutrition Society¹.

The early trials aroused much interest, further papers were presented at Rimini² and Warsaw³, and results of one of the Cambridge trials have now been published in the "Practitioner"⁴ indicating that in a controlled experiment involving over 100 obese patients on a low carbohydrate diet, including the Cambridge Formula Loaf as part of that diet, mean weight loss over eight weeks was 50 per cent higher in those patients receiving 5 oz per day of the high protein bread than controls given the same quantity of ordinary brown bread. The initial success was found to be encouraging to patients themselves who continued to show more substantial and sustained weight losses over longer periods of time. Evaluation of the potential benefits has not been confined to this sort of generic type of population. They have also been extended to geriatric and school child levels. An interesting example of the latter was an examination of over 12,000 Leicester school children annually over a seven year period, covering the age range of 4-19. This showed in the first stage that the overall incidence of obesity in these children was 2½ per cent. The abnormality occurring in the 7+ age group, whose parents were in the lower income groups. The chief cause was, as could be expected, the over consumption of carbohydrates, but there was also no evidence to suggest that psychological imbalance had any importance in these particular figures. The treatment by conventional low carbohydrate, high protein diet was moderately successful, but replacement of the daily allowance of 4 oz of bread in such a diet by the Cambridge Formula Loaf increased the mean weight loss by three fold, and the success rate, based on a 12 lb reduction, by nearly five-fold over a period of six months. The local authority workers in this study concluded that dietetic advice for obesity prevention could be given to best advantage while children were in the age range of 7-12 years of age, and that the best form of therapy was a very high protein, low carbohydrate diet.

Finally, similar types of activities are being extended locally in the Cambridge area to geriatric cases. There is no published work available yet and experiments are still in the fairly early stages. In conclusion I would be very happy if you would care to have a look at the samples I have brought along, which will give you some idea of the nature of a commercial product based on this concept.

Table 1

Cambridge Formula Dietary Loaf Typical Analysis

Moisture	40.0%
Protein (N x 5.7)%	25.4%
Oil (all vegetable)	6.5% (by hydrolysis)
Fibre	1.6%
Ash	2.75%
Starch	12.6%
Sugars	2.4%
Available carbohydrate	15.0%
Pentosans	3.3%
Cellulose	0.9%
Sodium (Na)	0.4%
Iron (Fe)	1.5 mg/oz.
Calcium (Ca)	15 mg/oz.
Total Phosphorus (P)	100 mg/oz.
Phytate Phosphorus	50 mg/oz.
Vitamin B1 (Aneurin hydrochloride)	0.125 mg/oz.
Vitamin B2 (Riboflavin)	0.05 mg/oz.
Nicotinic Acid	1.0 mg/oz.
Vitamin E	0.55 mg/oz.
Pyridoxine	71 micro-g/oz.
Calories	64 oz.

Fatty acid composition (% methyl esters) of total lipids

Palmitic acid	14.8%
Stearic acid	3.2%
Oleic acid	22.0%
Linoleic acid	51.3%
Linolenic acid	9.0%

Amino Acid composition of crumb

Aspartic acid	1.55%	Methionine	0.37%
Threonine	0.97%	Isoleucine	1.04%
Serine	1.40%	Leucine	1.89%
Glutamic acid	7.65%	Tyrosine	0.95%
Proline	2.60%	Phenylalanine	1.32%
Glycine	1.08%	Lysine	0.85%
Alanine	0.95%	Histidine	0.71%
Valine	1.14%	Arginine	1.34%
Cystine	0.55%	Tryptophan	0.27%

All the vitamins and minerals are of natural origin.

References:

1. Proc. Nutrition Society, 1965, vol. 24, No. 2 p.xxviii.
2. Atti del IV Convegno Internazionale sui Lipidi Alimentari, Rimini, 25-26 September 1964.
3. 2nd International Congress of Food Science and Technology, Warsaw, 22-27 August 1966.
4. The Practitioner, 1968, vol. 201, pp. 491-496.

Paper 5

TRAINING OVERSEAS STUDENTS IN COMPOSITE FLOUR TECHNOLOGY

By Professor E. J. Rolfe, National College of Food Technology, Weybridge.

The work that I have to report is a certain amount of "ad hoc" work which has been done by students at the National College of Food Technology. We offer a number of MSc options in Food Technology and they attract a considerable number of students from developing countries.

The first experiments were carried out by a student from Thailand who was interested in the possibility of substituting wheat flour by rice in breadmaking. The student obtained four different varieties of rice from Australia, Spain, Argentina and Thailand and the polished rice grains were ground in a Buhler laboratory mill. The range of dilutions of the study was 0 to 50 per cent. A few initial experiments were carried out and confirmed the results previously reported elsewhere, that mechanical dough development (MDD) gave better results than bulk fermentation time (BFT). The quality assessment tests carried out were: loaf volume, compressimeter and penetrometer tests, oven spring and crumb pattern. The recipe was standard with dilution variable up to 50 per cent. Six loaves were baked from each dough, three used for volume measurement, and three for texture assessment and crumb pattern. The first observation was that the comparison between MDD and BFT showed that loaf volume was more sensitive to the addition of rice flour with the BFT process, and at 50 per cent dilution using MDD the quality was nearly as good as with all wheat flour using BFT.

In order to compare the various rices an arbitrary value was chosen which was related to the minimum acceptable standard for each parameter. The mean quantities of dilution for the flours were: Spanish 35 per cent, Argentinian 27 per cent, Australian 24 per cent and Thailand 16 per cent. These results bear out the points which were made both by Professor Aylward and Dr Asselbergs that one needs to check very carefully the quality of the raw materials. Analytically there seems to be very little difference between these four varieties of rice, but there is a considerable difference in the amounts which could be incorporated into the mix in order to produce a reasonable loaf.

With the rice flour as diluent one was obtaining a good crumb and texture, the flavour was good, the crust and the colour seemed to be quite good; rice although rather more expensive is more nutritious than cassava and so possibly the additional cost of rice against cassava does have some justification.

The second lot of experimentation was carried out by another student from Brazil and interest here was the utilisation of cassava flour to replace wheat flour in the manufacture of hard semi-sweet biscuits of the Marie type. I understand that in Brazil there is a compulsory addition of 3 per cent cassava flour to wheat flour at the mills and this does give rise to difficulties with fermented goods because the fibres of cassava flour interfere with dough development.

With regard to the utilisation of cassava flour in hard semi-sweet biscuits the tests which were used on the dough were water absorption, a strength test, i.e. "research" extensometer, the specific recovery test, water tolerance and finally the test bake described in BBIRA Report No. 79.

With regard to the biscuits that were prepared, the characteristics measured were: stack height, the weight of 12 biscuits and the diameter of 12 biscuits. With regard to water absorption it was found that this value increases with cassava flour addition and increases very markedly over 10% dilution.

In general the strength test results indicated that there was little change in extensibility up to about 15% cassava flour but it was markedly depressed when increased to 25%. Specific recovery was difficult to measure because the samples tended to bend on drying and this made the measurement of the biscuit diameter rather difficult, but it appears that the addition of cassava has little effect in this respect. Also there appeared to be little effect on water tolerance of additions of cassava up to about 25%. In test baking, as the cassava content increased it was found that the dough was easy to roll but the tendency to recover was reduced. In addition the cassava flour imparted a yellowish colour and a lighter texture and also some alteration in flavour which became particularly noticeable

when the cassava flour was increased up to 25%. The stack height falls slightly as the cassava is increased. The biscuit weights and size were unaffected. The hard semi-sweet biscuits are sensitive to consistency changes during plant baking and due to the higher temperatures used for mixing, mechanical stresses during plant sheeting, cutting and handling are likely to exaggerate any differences appearing in the test bake samples, where greater care is taken in the whole operation. If the water tolerance is really unaltered by cassava flour then it would seem that the plant operation would be unaffected by something up to 25% replacement by cassava but this would need to be verified on larger-scale machinery than we have at Weybridge.

The comment of the student was that he thought that the utilization of cassava up to 25% is indeed possible here, but some reticence was expressed due to the nature of scaling-up operations and he also felt that handling of the doughs required a certain amount of skill, more than he could gain in the particular time that was available during the project study.

Paper 6

A PRELIMINARY ECONOMIC EVALUATION OF THE USE OF NON-WHEAT FLOURS IN BREADMAKING

by Michael J. Edmonds, Industrial Economics Section, Tropical Products Institute.

Background

Economic information for developing countries concerning trade in wheat and its flour, patterns of consumption and the structure of baking industries, is surprisingly inadequate, but it is possible to gain a general impression of the present situation by the use of certain global figures. To take trade first, if the continents of Asia, Africa and South America are taken as a model for the developing world, there was an increase of 130 per cent in the imports of wheat and flour (expressed in terms of wheat equivalent)⁽¹⁾ into these areas between the years 1957-9 and 1966-8 (annual average). In the latter triennium this trade amounted to nearly 34 million tons per year at a mean annual expenditure of £1,035 million, and accounted for about 51 per cent of the world wheat trade. The rate of growth of imports into the developing areas of 10 per cent per year is greater than the rate of growth of world wheat trade as a whole, which is estimated as being in the region of 6.5 per cent per year. During the years 1966-8 a mean of 65 per cent of world trade was supplied by the USA, Canada and Australia.⁽²⁾

The proportion of traded wheat that is used for breadmaking cannot be quantified with any degree of accuracy. However an approximation and simplification can be made by distinguishing between three categories of wheat-importing developing countries. Firstly, there are those countries where bread has long been part of the staple diet, and indeed may account for the greater part of daily calorie intake.⁽³⁾ In such countries, generally to be found in the Middle East, and especially where coupled with low levels of per capita income, wheat imports are likely to be used almost entirely for breadmaking. It is also often the case that the breadmaking industries of these countries are characterised by a large number of small, simple bakeries, generally making individual styles of bread and each catering for a very limited market.⁽⁴⁾ The second category includes those countries where wheat-based foods other than bread form a large part of the staple diet, such as noodles in parts of South East Asia, or chappatis in India. In these cases the proportion of wheat imports used in breadmaking may be as little as 30%,⁽⁵⁾ though it is probably rather higher than this on average, especially since imported wheat, being predominantly of hard varieties will be used to a greater extent in breadmaking than the softer locally grown wheats. In the third category come those countries where cereals and starchy roots other than wheat constitute the principal source of food intake, where overall per capita wheat consumption is low, and where bread may be a comparatively recent innovation whose consumption is confined to a relatively small section of the population. In these countries it is probable that a higher than usual proportion of wheat imports is used for the making of biscuits and cakes, though these are unlikely to account for more than 15 per cent of imports.⁽⁶⁾ In the latter two categories it will normally be found that the structure of the baking industry conforms more to the pattern in the developed countries, with a preponderance of relatively large bakeries serving a large market, and using modern techniques.

Again, very little information is available on trends in bread consumption. It has variously been reported; that the income elasticity of demand for bread is greater than unity up to an income level of 150 shillings per month (£90 p.a.) in Nigeria,⁽⁷⁾ in other words demand for bread increases at a faster rate than income growth; that bread consumption is increasing at a rate of 20 per cent per year in Hong Kong and 10 per cent per year in the Philippines;⁽⁸⁾ that the baking industry is expanding by 7 per cent per year in Mexico.⁽⁹⁾ It can be concluded that although bread consumption in the greater part of the developing world is unlikely to reach the levels found in more developed countries, especially those in Eastern and Southern Europe where annual per capita consumption of over 200 kg is common, it is highly probable that bread consumption will continue to increase with population, and faster than income in the foreseeable future.

Imports of wheat, then, are likely to continue to be a drain on the scarce foreign exchange resources of developing countries for some time to come. Two factors seem to mitigate this trend to some degree. The first is the development of 'miracle' strains of wheat that can be grown in areas hitherto unsuitable to its cultivation. The overall effects of this cannot yet be assessed, but it should be remarked that these strains are generally 'soft', and undoubtedly there will remain large areas where wheat cannot be cultivated for climatic or technical reasons, and where a foreign exchange problem will remain. The second mitigating factor has been the growth of flour milling in developing countries. Though in absolute terms the amount of flour traded has increased the proportion of the total wheat imports into developing countries accounted for by flour (in wheat equivalent terms) declined from 22 per cent in 1957-9 to 12 per cent in 1966-8⁽¹⁰⁾. However it is found that the savings made available by local milling are of a small order, and expressed purely in terms of commercial outlays may even be negative since it has sometimes been found cheaper to import flour rather than unmilled wheat.⁽¹¹⁾

Given the foregoing trends, this paper seeks to determine whether worthwhile economies can be made by developing countries if a proportion of the wheat used in their baking industries were replaced by such products as cassava starch or sorghum flour supplemented by protein rich flours, such as soya, which are or could be produced in the developing countries. For a country importing 100,000 tons of wheat per year, this could theoretically lead to import savings of up to £800,000 per year if the maximum technical substitution rate were possible. In practice savings of this magnitude are unlikely to be realised, at least in the short run, mainly due to difficulties in increasing the supply of substitutes without undesirable price effects. On the more modest basis of one cassava starch plant being set up for the purpose of replacing flour, a gross sum in the order of £400,000 per year could be saved in foreign exchange. Though these figures are somewhat abstract they do give some illustration of the sort of savings possible.

Method of Evaluation

The method used to investigate the desirability of substituting locally produced flours for wheat flours has been to investigate the costs and benefits accruing from the importation of unmilled wheat and grinding it, and to compare these with the costs and benefits accruing from the local production of a composite flour made of five-sixths cassava starch, and one-sixth soya flour. These costs (inputs) and benefits (outputs) have been estimated in 'social' terms, that is as applying to the economy as a whole, rather than in 'private' terms, that is as applying only to whoever is processing the flour, since the substitution is likely to concern a collective political choice rather than a private investment decision. Furthermore, since price mechanisms in developing countries tend not to reflect the true scarcities of resources, a more accurate indication of the feasibility of a scheme is given when prices are expressed in terms of some constant numeraire, the most useful and convenient being world (foreign exchange) prices, rather than in terms of market prices in local currencies. Hence the figures used in this paper refer to parametric or 'accounting' prices. The overall comparison between the alternatives is expressed in terms of the difference between the net social profit of each, that is the excess of benefits over costs for each.⁽¹²⁾ The net effect of this procedure is to render the alternatives directly comparable, and to enable comparison with any other schemes suggested.

Certain limitations to this approach in the present study should be made clear.

In the first place this is a preliminary study which has not had the benefit of any fieldwork, so that the figures used are not specific to any country, and represent a rather general order of magnitude. Secondly, adequate empirical cost data on the processing of cassava and soya is not available, so that the figures used may be subject to wide margins of error. Thirdly no attempt has been made to construct a time profile of the alternatives, so that the constructions are purely static, and no forecasting or discounting is made of the future, so consequently the alternatives may not be strictly comparable. Fourthly, no comparison is made between traditional breadmaking techniques and mechanical dough development (the Chorleywood Bread Process) which is the best suited method for diluted breads.

Analysis and Conclusions

The detailed cost-benefit analysis is shown in the accompanying appendix, and indicates that the social profit deriving from the manufacture of a composite flour is considerably greater than that from milling imported flour. However it must be stressed that the figures used are of a very general order of magnitude, and consequently at this stage it should be recognised that the analysis indicates little more than that a good case exists for the proposed substitution.

Certain problems raised by the analysis require fuller exploration. First it is sensitive to variations in the prices of the various inputs, notably of wheat. If the price of wheat is assumed as being £5 per ton lower, then the net social profit of wheat milling increases to about £7 per ton. Similarly the net social profit will increase if the price of flour used is higher.

Secondly considerable problems are raised over the availability and price of the raw materials,

especially cassava. In areas where it has been grown as a subsistence crop, and commercialised only on a small scale, it is unlikely that the existing structure of production will be adequate to supply an industrial scale undertaking. Thus the establishment of plantations seems to be a prerequisite for effective production, and at present there are very few areas in the world where it is presently grown on a plantation basis. Protein rich inputs are less likely to suffer from these supply constraints, though there may be other effects resulting from changes in the situation in world markets.

The third set of problems raised by the analysis concerns the efficiency at which existing facilities for the production of local flours operate. From such information as we have available, it seems that in some cases the costs of production are very much higher than those used in the costing here. If there is a long learning period involved in the production of these composite flours until they can be efficiently produced, then it can be argued that the object of the exercise, which is to promote short term savings in imports is lost since the resources could be better used in import substitution or export promotion elsewhere in the economy.

A fourth set of problems is concerned with the acceptability of these composite flours to the baking industry and to the consumer. It has been noted that it is often difficult to change the consumption habits of people at low levels of income and sophistication. An explanation may be that if people have a very limited diet then they are more conscious of small changes in the composition of that diet. Since it is the case that in many developing countries, local idiosyncratic types of bread are favoured, bread using non-deployment wheat flour will be virtually a new product, likely to require the deployment of considerable marketing expertise.

Each of these problems requires further analysis, and it is suggested that this can now best be carried out as a thoroughgoing feasibility study for the project related to a specific country or area, so that actual processing costs, raw materials availability and impact on the baking industry can be assessed.

FOOTNOTES

1. Hereafter 'Wheat' is used to mean 'wheat and flour' unless otherwise specified.
2. FAO Trade Yearbooks 1961 and 1969. The rate of growth of world trade is derived from the mean of total imports and total exports, and understates the total if import figures are correct, overstates if export figures are correct.
3. Pelshenke, P. F. 'The Bread Situation in Lebanon' FAO EPTA No.1819, Rome 1964, pp 4—5.
4. cf Dalby, G. 'The Baking Industry in Egypt' Bakers Digest 37 (6) Dec. 1963 and Dalby, G. 'Bread Baking in the Sudan and Saudi Arabia' Bakers Digest 40 (3)
5. cf 'Baking Industry in South East Asia' Food Industry in Japan 1 (1) Spring 1967
6. Extrapolation from figures given by Baker Perkins International
7. Kilby, P. 'African Enterprise: The Nigerian Bread Industry' Stanford
8. 'Baking Industry in South East Asia' op. cit.
9. Lambert, S. 'Mexico: Harsh land of beauty and of bakers' The Baker April 1968
10. FAO Trade Yearbooks
11. Szarf, A. 'Modern Flour Mills in Developing Countries' FAO Monthly Bull. Agric. Econ. Stats. 15 (6) 1966
12. cf Little I.M.D. and Mirrlees J. A. 'Manual of Industrial Project Analysis in Developing Countries' Vol. II OECD Development Centre Paris 1969

Appendix

A PRELIMINARY ECONOMIC EVALUATION OF THE USE OF NON-WHEAT FLOURS IN BREADMAKING

Calculation of the costs and benefits of milling imported wheat and of producing a composite flour from cassava starch and soya.

1. Wheat Milling

Table of costs and benefits

Inputs (costs) £ per ton flour		Outputs (benefits) £ per ton flour	
Wheat	42.5	Flour	42.75
Labour	1.8	Bran	7.06
Other	4.8		
Total	49.1		49.81

Net social profit: £0.71 per ton

(a) Wheat

On the basis of a cif price of £31 per ton,⁽¹⁾ and an extraction rate of 73 per cent. This extraction rate is somewhat lower than that normally attained in developing countries, but has been used in order that a reasonable price for the flour can be imputed. Studies of the cost structure of 17 flour milling industries in developing countries indicate that the mean percentage of the total flour cost attributable to the unmilled wheat was 85 per cent.⁽²⁾

(b) Labour

The same studies show that some 4.3 per cent of total costs can be attributed to labour and a further sum should be imputed for the value of the unskilled labour embodied in the other inputs. If this contribution is estimated at 10 per cent of other inputs then the total labour input is reckoned as 5.3 per cent of money cost, or £2.65 per ton of flour. However, since industrial labour in developing countries is generally paid more than its scarcity would warrant in a price-efficient economy⁽³⁾, the figure requires deflating to reach a more accurate measure of its value. In this case a deflator of one third has been used.

(c) Other Inputs

These are very diverse, no individual item accounting for more than 2 per cent of the total, so they are measured without further adjustment.

(d) Flour

The value of the flour is measured in parametric terms according to the fob price were it to be exported, that is the opportunity cost of the flour in its alternative to home use. There is some difficulty in establishing an accurate fob price for flour, since sources show the fob price as being higher than the cif price. However, an average fob price for world exports over the years 1966-8 has been taken.⁽⁴⁾

(e) Bran

Since bran is a by-product of the milling process its sales represent a benefit from the manufacture of flour. It is assumed that flour and bran are produced in the ratio 73:27, so that .37 tons of bran are produced for every ton of flour. The price per ton of bran was derived from the FAO average export prices for 1966-8 of £19.08 per ton,⁽⁵⁾ which yields .37 x £13.8 per ton of flour.

(f) Net Social Profit

It should be noted that this is a very small figure in this case. If marginally different assumptions were

made about the prices of flour and bran the figure could become negative. This is explained partly by the fact that prices of wheat flour are so close together and partly by the fact that transport costs are not taken into account. The conclusion is, therefore, that the milling of imported wheat is at best a marginally worthwhile activity for developing countries.

2 Substitute flour making

Table of costs and benefits

Inputs	£ per ton cassava starch
Roots	20.7
Other materials	5.6
Labour	0.9
Overheads	2.1
Depreciation	2.5
Total	31.8

	£ per ton soya flour
Soya beans	42.0
Other materials	11.7
Labour	5.0
Overheads & depreciation	18.9
Total	76.6

Inputs	£ per ton composite flour	Outputs	£ per ton composite flour
5/6 Cassava total	26.5	5/6 ton Cassava starch	28.4
1/6 Soya total	12.8	1/6 ton Soya flour	16.7
Total	39.3	Total	44.1

Net Social Profit: £4.8 per ton

(a) Cassava roots

It is rather difficult to settle on a price for cassava roots largely because the evidence available is somewhat contradictory. A price of £4.6 per ton has been used since this is the price actually paid by a plant in Uganda,⁽⁶⁾ and similar prices have been reported from Madagascar⁽⁷⁾ and Gambia⁽⁸⁾.

It should be noted that since the bulk of the world's cassava is produced by peasant farmers, the existence of a starch factory tends to distort the market for cassava roots, so that the resulting prices may give a very inaccurate idea of scarcity, and the price used would appear to be more useful than a much higher one that seems to be paid by the factory in Togo,⁽⁹⁾ which has experienced a great deal of difficulty with supply from peasant sources. A ratio of 4.5:1 has been used for converting roots into starch, though from available evidence it appears that there are very wide differences in the percentage of starch recovered. The resulting price has not been adjusted since the principal input into cassava cultivation is labour which can be assumed to be at or near the subsistence level.

(b) Other Inputs into Cassava starch production

The other costs in this table have been largely derived from a feasibility study made for Nigeria some years ago, though they have been compared with data available from other sources. Certain adjustments have been made as follows:—

1. Under 'other materials' deductions have been made for import duties.
2. The figure for labour has been deflated by one third, as above.
3. The figure for depreciation was deflated first by excluding import duties, then by deflating 10 per cent of the initial construction cost by one third as an allowance for the labour input.

(c) Soya beans

A price of £35 per ton has been used which is close to the mean world price for the years 1966-8,⁽¹¹⁾ and to the price quoted for Uganda, where information is available on soya flour production.⁽¹²⁾ A factor of 1.2 tons of beans per ton of flour has been used. Other inputs have been taken directly from the mentioned source, except that labour has been deflated by one third.

(d) Although the output is a single composite flour, no separate valuation can be placed on it since it is not a traded commodity. The approach has been, therefore, to take fob prices for cassava starch, using as a basis producer prices in Togo⁽¹³⁾ and Thailand⁽¹⁴⁾ and for soya flour, using prices quoted by UK manufacturers.

Sources used

1. FAO Trade Yearbook 1969
2. Szarf, A. 'Modern Flour Mills in Developing Countries' FAO Monthly Bull. Agric. Econ. Stats 15 (6) 1966. and 'Profiles of Manufacturing Establishments' Vol. 1 UNIDO New York 1967.
3. There is an extensive literature on this topic.
4. FAO Trade Yearbook 1969.
5. FAO Trade Yearbook 1969.
6. Private communication.
7. L'Agronomie Tropicale XXIII (1) Jan. 1968, p89.
8. Private communication.
9. 'Inventaire Economique du Togo 1967'
10. A. D. Little Inc. 'Feasibility of a Cassava Starch Industry in Nigeria' 1964.
11. FAO Production Yearbook 1969.
12. 'Demand for Soya-based High Protein Food in Uganda'. Economist Intelligence Unit 1969.
13. 'Inventaire Economique du Togo 1967'.
14. A. D. Little Inc. op. cit.

General Discussion

This was opened by **Mr Collins** who asked what consideration had been given to temperature control when using Mechanical Dough Development (MDD) in the tropics; he also questioned the use of 150 parts per million ascorbic acid whereas the normal commercial level was 75 ppm.

Mr James said that water would have to be chilled and crushed ice could be used for this purpose.

Mr Kidman agreed with this and added that the temperature of the stored flour etc., should also be taken into account. He said that in general at the Borough Polytechnic MDD was not used in their composite flour investigations because of the water cooling problems.

Mr Pringle then asked what was the highest temperature at which satisfactory results had been obtained.

Mr James answered that about 100°F was so far the highest temperature giving satisfactory bread. He then said, with regard to Mr Collins' point on ascorbic acid, that since the test doughs were made in small quantities, a higher level of ascorbic acid was necessary.

Mr Farrand raised two points: firstly that Dr Dendy referred to flour protein in this country being 12 per cent and the average is in fact 11.4 per cent; and secondly he questioned the economics of the use of L-cysteine and Activated Dough Development (ADD).

Dr Dendy replied that the figure referred to was 11.7 per cent which had been rounded up to 12 per cent.

Mr Kidman asked whether any work had been done at high temperatures on the reactions of cysteine, bromate etc., since these would perhaps have different effects at differing temperatures and he was anxious because more accurate control would be needed at higher temperatures and ADD was particularly sensitive to processing delays.

Dr Chamberlain questioned Mr Kidman's remarks on the reactions of cysteine and bromate saying that one would counteract the other and he stressed the importance of the ratio of one to the other.

He went on to say that it was not fully understood why MDD gave better results than Bulk Fermentation Time (BFT), though this may be due to short time, but if this is the vital point ADD should be as good; as this is not the case, it would appear that time is not critical.

Mr Farrand pointed out that TNO use larger quantities of emulsifying agents such as calcium stearoyl-2-lactylate (CSL) than TPI do. Could Mr de Ruiter explain the importance of this.

Mr de Ruiter said that it was not necessary to use CSL, 3 per cent of fat with a high melting point would do. TNO had found that for low protein and composite flours, CSL was one of the best bread improvers, permitting higher levels of dilution.

Mr Farrand commented that Dr Tsen of the Kansas State University also found better results were obtained with CSL. Some work had been done on the starch water absorption compared to that of gluten; if starch takes up water faster than gluten then there is competition between the gluten and starch, with startling results. Work was also being done on gelling in the presence of surfactants.

Dr Chamberlain asked whether the effect of surfactants was to raise specific volume.

Mr de Ruiter said that CSL improved loaf volume by 20-30 per cent and when it was not added the volume was poor. He agreed that Dr Tsen in Kansas worked with CSL but said he had had better results with polyethoxylated glycerides.

Professor Aylward then asked Mr de Ruiter what fat was added to the formulation.

Mr de Ruiter said that with soya and cassava flour only, no fat was added, but with wheat composite flour usually ½ per cent CSL and 4 per cent normal bread fat.

Professor Aylward said that fat overseas was not readily available, so what would happen if locally available oils were added.

Dr Chamberlain replied that oils would not substitute for bread fat. He also pointed out that the use of CSL is not yet allowed in Britain.

Mr de Ruiter agreed but said it would soon be allowed in the USA in quantities up to ½ per cent.

Mr Kidman mentioned the question of the mechanical handling of dough containing abnormal amounts of water.

Mr Farrand said that yield was vital and was directly related to the amount of water in the dough. He explained that they were still working on the problem of water absorption and stressed the importance of correct dough mixing.

He went on to say that one of the reasons why the protein content in bread fell from 12 to 11 per cent was tied up with the MDD process, for if the enzymatic system is not controlled, the work of controlling starch absorption was lost, especially with high temperature doughs, which means that in this country the enzymatic activity in the wheats must be controlled.

Mr Farrand pointed out that a larger amount of weak flour could be used in a batter process and Mr Kidman agreed with this statement.

Mr de Ruiter then discussed the Dutch short fermentation process and explained that this method gave better results than MDD when using composite flours.

Mr Kidman added that short doughs required less hydration time, and their tests showed that using a 2-hour fermentation period, a good loaf could be produced, comparable to MDD, using up to 25 per cent cassava starch.

Mr Hall said that it was important to take into account that developing countries are producing an increasing amount of home-grown soft wheats and this coupled with unskilled labour and difficult conditions should be borne in mind when deciding upon a process most suitable for developing countries.

Mr Kidman remarked that he was worried about mixing the composite flour at the mill, as the difficulty in the mills at the moment is control of quality from the beginning; on the other hand it was the only place to control quality.

Professor Aylward said that a point arising was that in many developing countries it is as cheap to import flour as to mill their own. His impression about Africa was that there were comparatively few countries with large scale centralised milling capacity, so that whatever is said about mixing in the mill it is relatively unimportant and a process should be worked out whereby the baker can be trained in the best methods of mixing.

Mr Edmonds commented that there were in fact a number of flour mills in Africa, and added that Nigeria milled all its own flour and that here central milling was complete.

Mr Farrand pointed out that reference must be made to the agricultural problems in the country. Kenya was self-supporting in milling and produced bread of similar quality to this country and could possibly be used as an example for others, in fact milling was profitable in Kenya. But a discussion of economics and technology would be useless unless the agricultural and economic potential of the country was considered as well. Milling and baking could not be separated from the agricultural situation.

Dr Dendy said he felt that one should exclude countries who grew their own wheat or had neighbouring countries growing wheat: these were generally high altitude countries. This discussion should perhaps be confined to countries importing wheat and those countries could perhaps develop an agro-industry based on local non-wheat sources blended with imported wheat.

Mr de Ruiter said that in those countries where there are wheat mills, the Government must be prepared to legislate on the blending of composite flours, which could be done preferably at the mills, or in the bakeries, the latter being more difficult to enforce.

Mr Hall agreed that the bakers would tend not to use the different flours, or use only the cheapest. There must be government control over this.

Mr Edmonds suggested that there might be a system of subsidies or levies on the different flours. He went on to ask with regard to TNO's project, what was the supply situation of cassava etc. in Colombia.

Mr de Ruiter said that the raw materials used in the experimental bakery would be taken with them, as in Colombia, though there was a cassava starch industry, the price was about double that of the world price and the soya flour quality was poor since it was used for feed purposes not human consumption. For the present, cassava starch production was low and they now had three demands on their supply: 1, for the world market; 2, for technical purposes within Colombia, and 3, for the composite flour projects. In some areas cultivation of new land for cassava production has been started and it is intended to increase the cassava starch industry—Colombia has requested a cassava

starch processing expert.

Mr Kidman asked whether cassava was a more difficult crop to grow than others.

Dr Asselbergs replied that mention had been made of the economic aspect; Colombia produced several hundred thousand tons of wheat annually, and if the Government wished, wheat production could be increased, but politically it would be more expedient to support the cassava growers rather than the wheat farmers, who were already well off.

Miss Hollingsworth asked whether it was general that the cassava was grown by the small farmer and wheat by the larger.

Dr Asselbergs replied that most of the good land belonged to the rich farmers, the poor land being left for the subsistence farmer. Basically any farmer who wanted to go into cassava production could do so, but a lack of machinery and practical knowledge as well as ability, limited the profitability of his operations.

Miss Hollingsworth queried whether the small farmer sold the cassava or kept it for home consumption.

Dr. Asselbergs answered that at present home consumption was great because the price was too low, and until handling of the product from the farm was improved, the position would remain unchanged. The improvement of outlets, transportation and price might result in the solution of the small farmers problems.

Before a composite flour programme could be developed successfully, it required a policy decision from the government concerned. Technically there was still a great deal of work to be done and the points made indicated that there were still a large number of unknowns in the baking of bread; unless research established the fundamentals of breadmaking, the next step would remain undone. The fundamental properties of bread must first be understood before they are extended to other raw materials.

Mr Pringle then said that there would seem to be three reasonable methods of producing bread with only some technical difficulties, but the precise technical problems were not known and would only be discovered on reaching the individual country concerned. The next step should be to establish projects in different countries and work out the problems resulting in these countries, and take whichever process would be most applicable to that country, looking at the raw materials available, political and benefits etc., and thus working out the solution to suit each situation; to do too much work in this country was unnecessary. The need of the moment was field trials with a commercial feasibility study.

Dr Asselbergs reiterated that the issue was that the work being done in Europe was designed to approximate the type of bread used; experiments here were necessary to obtain the basic knowledge needed.

Mr Pringle asked whether universal agreement came from the successful completion of a project on the site, such as those in Brazil and Senegal and whether this did not lead to encouragement.

Dr Asselbergs replied that sometimes the enthusiasm of local people was greater than a project warranted.

He again emphasised that there was still an amount of fundamental knowledge lacking. On field trials it would be logical to approximate to what the people were used to, and to do this one needed to know about the baking process of wheat products, hoping that with this knowledge the new baking problems would be solved.

Mr Hall suggested that the subject of gluten was resumed and asked whether anybody had any comments on a possible substitute.

Mr Evans said that in 1932 a kind of bread had been made from maize starch and locust (carob) bean, and recently a bread with no wheat, containing 4 per cent guar gum and 96 per cent starch had been developed and he wondered whether perhaps bread could be made from a gum and cassava and soya flours.

Professor Aylward added that Cornell in 1950 had done similar work with carob gum.

Mr Evans suggested that if the gum was native to the country, they could manufacture their own. He went on to say that maize treated with lime made a foaming agent. If all the cereals were treated with lime to make a material which would aerate, this might be worth investigating.

Mr Hawley agreed with Mr Evans in looking at the use of lime as an emulsifier and said that some very rewarding results could be obtained by enzymatic or lime treatment. CSIRO have been working on this recently with milk biscuits. There would seem to be a distinct scope for more work on lime with soya flours etc.

Professor Aylward commented that the lime treatment in Mexico had been used as a preliminary for a wet milling process for maize which was then made into pancakes.

Mr Clarke was then asked to speak, having worked on glutenless breads, and he said that a loaf similar to the TNO loaf was available in the UK to patients suffering from coeliac disease. It was made, basically, from milk powder and wheat starch. Also wheat starch and modified cellulose combine to produce a loaf suitable for use in protein-free diets such as phenylketonuria. It was not found necessary to add emulsifying agents to either type of bread.

Mr Collins remarked that these particular breads were unlike 'bread' and the acceptability must be considered and with all due respect to TNO, that their bread was not 'bread' as it was understood here.

Dr Chamberlain said that it must be decided what we were trying to do for these countries; if we were trying to copy the bread of a minority, then the sort of bread made from entirely non-wheat materials would not be acceptable as ordinary bread; if on the other hand it was planned to introduce to a large section of the population something not intended as a copy of any existing product, but new, nutritious and palatable, then this discussion on substitution would be irrelevant.

Mr Hall agreed and commented that whereas Western type bread was growing in popularity in most developing countries as a prestige food, if the appearance of this bread was changed, as it was at present in the case of 100 per cent wheat replacement, then there would be the sociological problem of consumer acceptance. He said that he thought that for the present it was important for work to continue along both lines.

Mr Farrand agreed that acceptability was a very difficult problem. Even in this country not all bread was acceptable: it was said earlier that bread containing millet was "an excellent product equivalent to whole-meal bread . . .", but only 5 per cent eat whole-meal bread, so that whether it was an excellent product or not was debatable.

Miss Hollingsworth asked whether FAO had really taken into consideration the question of food habits in developing countries. If British type bread was preferred, this was fine, but if French and Italian bread was liked, it would be better to give them that.

Dr Asselbergs said that in many African countries though they do not produce wheat the bread consumption was rising rapidly and it must be known what the trend to bread was, and sociology was involved here, though this had not yet been studied in detail.

Mr Hall agreed that there was a steadily growing demand for bread in developing countries. There must be a dual basis for this work: trials in various developing countries must be done, but a base for supporting work here must be maintained.

Mr Pringle said that it was very easy to take the wrong direction due to lack of experience in the country concerned. An example of the intelligent way to approach things was Mr Perten in Senegal, who before going out there, visited research establishments in this country and in France, and even so was almost certainly finding difficulties in Senegal, in particular in persuading the bakers to use the composite flours.

Mr Hall commented that he had in fact found the bakers were not so resistant to its use as the millers. The bakers were quite happy if they could be satisfied that it was more profitable.

Professor Aylward pointed out the enormous effect of urbanisation and that with the rapid and continued growth of cities this was where the demand and problems were, and this was also where the political pressures and the movement to modify food habits quickly was found.

He added that not so much in the developing world as a whole, but in parts of Africa and Asia which have been under British cultural and political influence, the preference for the British type breads was found, whereas on the other side of Africa the best quality French loaf was preferred. It was in the former Commonwealth countries that the realities of our problems were and in that context it was relevant to have the base here for the brains, but pilot trials must be carried out overseas.

Mr de Ruiter commented that consumer acceptability did not seem to be such a problem. He also remarked that without gluten there was less coherence than with wheat flour.

Mr Farrand said that African bread was distributed over longer distances than in UK and that what was intended to be done with bread when it was sold must be taken into account when considering the water content, since one of the dangers of putting more water in the bread was that the onset of mould in warm weather becomes quicker. He asked whether mould inhibitors were being considered in the list of additives.

Dr Dendy replied that inhibitors were being considered, but only in field work.

Mr Kidman commented that the difficulty with anti-mould agents was their depressing effect on yeast activity, and if anti-mould agents and dried yeast were used together, there might be problems.

Mr Sykes agreed with Mr Kidman and added that one should beware of estimating yeast requirements overseas from this country, since yeast deterioration will affect quantities used.

Dr Dendy agreed that in tropical countries mould appeared more rapidly, but he pointed out that the bread was used in small quantities and not kept so long.

Mr James commented that in Kenya the shelf life of bread was at least 4-5 days.

Mr Farrand said that there was a 15 to 20 per cent increase in bread consumption per year there. He went on to say that the important problem in bakery work was rope and once it had arrived it was difficult to get rid of; it should be dealt with by prevention.

Mr Hall remarked that TPI had used dried yeast and asked if there were any ideas concerning yeast nutrients or yeast production.

Mr Sykes went on to comment that in Dr Dendy's paper he was a little surprised to see that the broth was aerated as this was rather impracticable, but in any case much the same result could be achieved by anaerobic fermentation. How much further activity could be improved by prolonging the period of fermentation was not known. Certainly a considerable improvement could be made by adding sugar to the suspension but attempts should not be made to grow yeast by aeration as that was rather difficult ground, particularly if a consistent product was required. If the bakery was to be mechanised then yeast of consistent quality was required, and if it was to be grown as suggested it would be difficult to maintain quality; even here manufacturers have difficulty growing yeast and on the spot it would be very much more difficult, but he agreed that some form of pre-fermentation would save money by activating the yeast for MDD type dough. It was mentioned that sugar was added to the flour because the yeast was not fermenting maltose very well: would it not be more likely that in a diluted flour there was not sufficient diastatic activity to supply the maltose, perhaps when using composite flour steps would have to be taken to ensure a supply of yeast nutrient either by adding diastatic supplements or as was done by adding sucrose.

Mr Kidman said that in their experiments in this they had used a thick flour-based brew, which had two advantages: that only a simple preliminary whisking was needed, and the supply of the type of nutrient necessary to start off the yeast activity.

Mr Farrand commented that unless care was taken it could be one of the most effective methods of producing rope.

The value of biscuits as a means of protein supplementation to the diet was discussed and **Dr Spensley** agreed that biscuits certainly had a place, but secondary to the bread problem.

Mr Hall asked whether a corporate group could be useful in the future, or whether another type of activity would be helpful.

Mr Bamford then asked whether only TPI and TNO were involved.

Mr Hall replied that in the use of non-wheat flour, the Polytechnic of the South Bank and Weybridge had done some work, but only TPI and TNO were engaged on it full time.

Mr de Ruiter mentioned that the International Association for Cereal Chemistry planned to arrange a study group for composite flour on 24th May which would be held in Vienna, firstly to note what was being done and in what directions, and also to avoid duplication. TPI, TNO and the Kansas State University were already doing work on this subject, Canada was just starting and several developing countries were becoming interested.

Mr Bamford asked whether there was a co-ordinating body or did FAO act as such. He went on to say that Mr de Ruiter had mentioned that other people were doing the same work, was this out of the blue or stimulated in any way?

Mr Hall replied that most of the work had been stimulated by FAO and some could have arisen from reports on the work.

Professor Aylward said that he had one comment to make apart from the general picture, which was that if any of these programmes were to work in a country abroad, people must be on the spot. What was wanted, in former British Colonial territories in Africa, was an extension of the City and Guilds type of courses, with particular reference to the craftsmen/technicians: the training of craftsmen was very important; a neglected field of Technical Assistance was the training of technicians/craftsmen.

Mr Kidman agreed that in the bakery field training was essential, but to one stage above craftsmen, in this instance the baker, who needed the knowledge to apply the new techniques. It was no use talking to millers, for example, about adding starch etc. unless they know what was being done to their own flour.

Mr Hall remarked that bakery courses organised at the Polytechnic of the South Bank had overseas students attending, and asked Mr Bamford if he could elaborate.

Mr Bamford replied that they had had a number of people from overseas, some of whom were agricultural graduates or even engineering graduates who were required to explore possibilities in the baking field and these people had no knowledge of baking, and short intensive courses in bakery

technology were provided; but there had been a number of overseas students of varying ability, mostly sponsored by companies, very few of the type referred to by Professor Aylward, except for a few some years ago.

Dr Spensley asked if there was any follow-up on the students who had done the training.

Mr Bamford replied that a good 50 per cent of past students in fact were using their knowledge at a technician level. He pointed out that the business of education had been neglected in countries nearer home and before technical advances, such as gluten substitutes etc. were talked about, training must be considered.

Mr Freeman said that industry had a vested interest in helping. The American Institute of Baking had financed free scholarships for students from Japan and in consequence their baking industry was solidly American now, and we should be thinking more about this, and he stressed the importance of field work at this stage if commercial success was wanted. He went on to say that both FAO and TPI had got people and research stations out in the field and there should be reports from them on local problems and requirements. He said that though his firm maintained contact with some of the research people, they got no official reports, and this was really something that should be done, through FAO and/or TPI.

Mr Pringle said that earlier Professor Aylward had made the point that for food-bread—to be of any value it must be eaten, and any programme if it was of any value had to be implemented. It was a matter of convincing the baker to use composite flour and this was the major problem.

Dr Asselbergs remarked that this was a point that had been giving some concern. Demands were received for technical assistance and advice, and a solution was expected, not problems.

Mr Freeman said that there could be no fixed pattern to present to a country as each country was individual. The persons sent out would have to be intelligent people, capable of interpreting the situation and able to use the support that FAO and TPI could give.

Dr Chamberlain agreed with this and added that it bore out what Dr Asselbergs said that there was a need to do more research into additives, substitutes and reactions etc. but added this was not a limiting factor. He went on to say that his own Association had already been working for nearly 30 years on gluten, but they could not wait another 30 years. He thought that all the technical knowledge to make bread now was there, but what was needed was to get out and do field work.

Mr Hall said that it would be necessary to obtain the consent and support of the overseas governments and it was essential to get a clear statement of intent from the government concerned before starting, and then obtain the official request. It was proposed to do this in Nigeria, where they have stated unofficially their intent and the formal request is coming through, to set up an experimental bakery at the Federal Institute of Industrial Research in Nigeria, which would continue the work done here on the use of indigenous materials in baked goods under local conditions—which we agreed was so essential—with the assistance of one of our bakery technologists for at least six months, to help set up equipment, supplied by us. He will also help them to set up an advisory service for the baking industry to help the small bakers throughout the country with advice on what improvements could be made, what mechanisation is needed, and to help all those people who need guidance to be able to make a start on improving themselves.

Mr Kidman added that again it was the need for basic education. He went on to say that when setting up a research institute etc., the question of training people to tell others about it must also be considered.

Mr Hall agreed with this, but added that the availability of such people to take training was very limited; in the Nigeria project for example, the man concerned there could not be spared to come over for training at the Polytechnic of the South Bank.

Mr Freeman asked how far was TPI prepared to go along with industry with a vested interest, and stated that if they, as a company, knew what was going on at the research centres, it would not be very long before technical people were sent over, but they would want a return, and in this way the TPI/FAO projects would stand a better chance of getting off the ground.

Mr Hall replied that TPI had no objection to letting industry know what was going on in the various countries, but he thought it would be improper to let one firm know exclusively; one could imagine the criticism raised by rivals if it were believed that one company had a private source of information from a Government department, but TPI would be very happy to let industry as a whole know. He said that TPI as an institute could justifiably give the British industry priority in information, but FAO had to let everyone know without any such priorities.

Dr Asselbergs remarked that if a private company wanted to go ahead and investigate possibilities, FAO would be quite happy. The requests came from governments, so that when the documentation was sent to the member governments a number of reactions could be expected and these reactions

could be circulated to this group, which might be of help to formulate their activities. FAO would certainly be glad to collaborate.

Dr Spensley commented that just as FAO had its Industry Co-operative Programme, so it was the policy of TPI to co-operate with industry. In fact, if a project did not end up in industrial hands, then it was not a success and certainly the links with industry were valued, but he agreed that a Government body must not seem to favour one industrial firm rather than another.

Mr Freeman added that not only was TPI helpful to industry but it was also dependent on industry and co-operation was to the mutual advantage of both.

Mr Kidman then asked how close was the liaison between TPI's work and the information service of the Research Association. How much of TPI's information was it considered necessary to pass on for these information services.

Mr Hall said that a close relationship existed with them, but to what extent information was fed, perhaps **Dr Dendy** could elaborate.

Dr Dendy regretted that no information had been given to the RAs, though a number of informal discussions had been held.

Mr Kidman then said that information on conditions in developing countries and what was going on there, if circulated widely, might well help industry in deciding whether to send people over.

Dr Chamberlain commented that it would not be appropriate for the RAs to act as a publication agency for TPI, but the RAs have publications which reach about 90 per cent of interested industry, and that if anything of interest came from TPI it might then well be appropriate to do a short article because it would be of potential interest to the readers.

Professor Aylward commented that when he was a director of an RA some years back, the scope was rather limited, but now with the extension to overseas membership, the uses widened, and one of the best suggestions for Technical Assistance was the actual formal membership of a group abroad. He had the feeling that the existence of the British RA system was not known in many places abroad and their existence should be publicised together with their information service and educational tie-ups. Whereas any agricultural mission had an agricultural advisory service, there was no food advisory service as such, and the RA could help in this way.

Dr Spensley said that TPI was preparing a booklet giving sources of industrial and technical information in Britain available to developing countries. Returning to publications, TPI had its own journal, as did Chorleywood, and some information went out in this, and others in special reports.

Mr Freeman said that for the actual implementation of processes it would probably be necessary to involve the government, or a private individual or company of the country concerned. He did not think it beyond the realms of possibility to set up a joint venture between a commercial concern and the government of the developing country. He pointed out that the British baking industry was very sophisticated and well aware of what was going on abroad; perhaps one of the bakery groups would be interested in the idea of a joint venture in a developing country.

Mr Hall said that one approach had been made, perhaps an unfortunately timed one, and on this occasion no interest was expressed. He went on to say that TPI was not unaware of the advantages of joint ventures of this sort, obviously the expertise was of enormous value and it was more probable that any project would succeed in developing countries if it had the financial and technical participation from a company with already acknowledged expertise. UNIDO already acted as a channel for a very large number of requests for Technical Assistance, more and more with equity participation and he thought this pattern would grow considerably.

Dr Amos commented that this meeting had been called to expand and confirm the views of TPI on the subject of composite flours. The decision must rest with TPI as to whether this meeting had been helpful for them, if so, it might be thought worthwhile to have such a meeting twice a year, but with a more specific agenda, to bring up points with which help was needed, and most people present would probably be prepared to give up time to further this project.

Concluding the discussion **Mr Hall** replied that the rather general agenda was deliberate, to discover in what fields lay the need for discussion; some items had aroused a lot of interest with many alternative opinions, others not so much. He said that it was hoped to maintain individual contacts with all the people present, and expressed the hope that they would come down to TPI's laboratories at Culham. He went on to say that he felt that it had been very helpful to have leaders in the field of bakery technology expressing their views on this subject, and he said how grateful TPI was to them for sparing the time to come and talk. He thanked in particular **Dr Asselbergs** and **Mr de Ruiter** for coming over to the UK to participate in the Symposium.

